

Challenges and Opportunities of Lifelog Technologies: A Literature Review and Critical Analysis

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Abstract

In a lifelog, data from various sources are combined to form a record from which one can retrieve information about oneself and the environment in which one is situated. It could be considered similar to an automated biography. Lifelog technology is still at an early stage of development. However, the history of lifelogs so far shows a clear academic, corporate and governmental interest. Therefore, a thorough inquiry into the ethical aspects of lifelogs could prove beneficial to the responsible development of this field. This article maps the main ethically relevant challenges and opportunities associated with the further development of lifelog technologies as discussed in the scholarly literature. By identifying challenges and opportunities in the current debate, we were able to identify other challenges and opportunities left unmentioned. Some of these challenges are partly explained by a blind spot in the current debate. Whilst the current debate focuses mainly on lifelogs held by individuals, lifelogs held by governmental institutions and corporations pose idiosyncratic ethical concerns as well. We have provided a brief taxonomy of lifelog technology to show the variety in uses for lifelogs. In addition, we provided a general approach to alleviate the ethical challenges identified in the critical analysis.

1. Introduction

The increase in digitized activities has produced a surge of digital personal data such as financial transactions, electronic mail, forum posts and visited websites. Simultaneously, the possibilities to extract digital information from the physical world have soared, not least since everyday objects are increasingly connected to the Internet and equipped with sensing devices. These developments facilitate digital collections of information about individuals, so-called lifelogs.

Lifelogs, and the activity of lifelogging, is a new and evolving field. Consequently a generally accepted definition of lifelogging has yet to be crystallized. We use the following working definition: a lifelog is a “form of pervasive computing consisting of a unified, digital record” (Dodge & Kitchin, 2007, p. 2) about an individual and the physical and digital environment in which the person is situated when lifelogging using multimodally captured data which are gathered, stored, and processed into meaningful and retrievable information accessible through an interface.^{1,2} In a lifelog different data from various sources are gathered and processed to form a record from which one can retrieve information about oneself and the environment in which one is situated when lifelogging. It could be considered similar to an automated biography. The storing, processing and organizing of data happens by default, requiring no active input from the lifelogger. There is also a sense of ubiquity as data for lifelogs are obtained partly through wearable devices such as the smartphone and other similar gadgets. The amount and variety of information that can be stored in a lifelog has increased significantly. Moreover, the burden of recording a lifelog has lessened by the increased immersion of ICT devices in everyday life, such as the smartphone, which can be used to capture information about physical as well as digital activities without human intervention (Goggin 2005).

¹ Similar to lifelogs, the term ‘pervasive computing’ lacks a clear-cut definition as it is also at an early stage of development. However, there are certain characteristics widely ascribed to pervasive computing which are applicable to lifelogs:

- “Embedded”: integrated in the environment
- “Context aware”: ability to recognize individual users and situations
- “Personalized”: they can be made to conform to individual preferences
- “Adaptive”: they can change as a reaction
- “Anticipatory”: they can change without interference (Aarts & Marzano 2003, 14)
- “Autonomous”: they record data about the wearer’s life in an independent way with no selection of what to record and what not to record

² This definition is a modification of the definition as formulated by Dodge & Kitchin: “A life-log is conceived as a form of pervasive computing consisting of a unified, digital record of the totality of an individual’s experiences, captured multimodally through digital sensors and stored permanently as a personal multi-media archive” (2007, p. 2).

Lifelogging has been an intriguing idea for some time. The idea surfaced in non-fiction literature before the technology was considered even remotely feasible. In 1945 Vannevar Bush, an American engineer, discussed a technology called the 'Memex', which would be a mechanized personal memory supplement (Bush 1945). Current technology has long surpassed the idea of the Memex. Gordon Bell and Steve Mann are well-known for gathering personal information to create individual databases of their lives. Mann started wearing a camera in the 1980s, as a precursor to what he calls lifeglogs, which can be conceived as a different term for a lifelog (Mann 2004a). From 2001 to 2007 Bell, who coined the term 'lifelog' around 2001, digitized all sorts of information about himself such as books he has read, music he has listened to, memos he has written and photographs from a wearable camera, all for the Microsoft project MyLifeBits (Bell & Gemmell 2009, p. 29).

The US Defense Advanced Research Projects Agency (DARPA) has a track record of developing lifelog-like programs or similar programs that capture personal information. Both 'LifeLog', a "system that captures, stores, and makes accessible the flow of one person's experience in and interactions with the world" (DARPA/IPTO 2003), and 'Total Information Awareness' (TIA), a data mining program to combat terrorism, were programs aimed to collect as much information as possible about a person. Both projects had to be withdrawn within two years as a result of controversy, because they were deemed too intrusive to privacy and an infringement of civil freedom (DARPA/IPTO 2003; DARPA 2003). However, shortly afterwards, similar programmes were established by DARPA such as 'ASSIST' (Advanced Soldier Sensor Information System and Technology) in 2004, which is a project to equip soldiers in a combat zone with sensors in order to augment their memory with digital reports (Schlenoff, Weiss & Potts Steves 2011; Shachtman 2004). There is also commercial interest in lifelog technology. For instance, Microsoft developed a camera especially designed for lifelogging, namely the SenseCam (Nokia 2007; Microsoft 2011).³ Today, lifelog cameras have the size of a sizeable postage stamp.⁴

Since lifelog technology is still at an early stage of development, a thorough inquiry into the ethical aspects of lifelogs could prove beneficial to the responsible development of this field. Hence, this article maps the main ethically relevant challenges and opportunities associated with the further development of lifelog technologies as discussed in the scholarly literature as uncovered by us. By identifying the challenges and opportunities in the ethical debate, we aspire to aid the responsible development of lifelog technology. This literature review offers researchers in the field of lifelogging an instrument to obtain more insight into the challenges and opportunities which are currently identified and the sources addressing these. By elucidating questions surrounding lifelogging, we hope to advance the ethical debate, which will, in turn, aid the technology's responsible development. At first we will clarify the method used to select the relevant sources. Next, we present the results of the review. Our main finding is that the debate on lifelogging distinguishes insufficiently between the various applications of lifelog technologies. First, we will bring more clarity into the concept of lifelogging to provide insight into the many domains. In the last part, we critically discuss the result of focusing in on a particular domain by highlighting an issue of concerning the choice of keeping lifelogs previously left undebated and present our general approach to alleviate ethical concerns. We propose/focus on *control* as a central value to alleviate ethical concerns. Moreover, we will provide some general recommendations arising from this approach.

2. Method

The Google Scholar database was used to find relevant sources. The first limitation was selecting only English language material. The search results were judged by reading the abstract. The whole article was skimmed in the case of missing abstracts. The second limitation was that the content had to involve ethical considerations on contemporary lifelog technology as discussed here. This latter criterion ruled out Bush's article about the Memex, which was still a far cry from current technologies. Also sources discussing a radical different

³ The SenseCam has been rebranded the Vicon Revue. The Vicon Revue surpasses the ability of conventional cameras as it combines various sensors, sensing the environment and the wearer, in order to capture environmental information and react on this information. Moreover, interfaces have been designed in order to query and present this information. Therefore, the Vicon Revue in combination with intelligent software can be considered one of the first primitive lifelogs.

⁴ Memoto is a lifelog camera which has GPS and organizes the photos it autonomously takes (Memoto 2013).

technology from what we consider lifelogs to be, such as a lifelog as a weblog, were left out of this literature review.⁵ The third limitation, partly arising from the previous, was to limit the search to articles from 2001 onwards. The year in which the MyLifeBits project started, creating the idea of lifelog technology as we currently know it. The fourth limitation entailed that sources had to elaborate on ethics. Therefore, sources mentioning applications to research ethics committees or acknowledging potential ethical issues without explaining or explicitly materializing them in their research are omitted from this literature review as they do not constitute an advancement of the ethical debate.

We searched for the terms “lifelog” and “ethic”, specifying that the words must occur anywhere in the article.⁶ It yielded 348 results, 30 of which were used in this review (Allen 2008; Byrne, Kelly & Jones 2010; Clowes 2012; Clowes 2013; Dib 2008; Dib 2012; Dodge & Kitchin 2007; Dodge 2007; Del Giudice & Gardner 2009; Jayaram 2011; Kang et al. 2011; Kelly et al. 2013; oops 2011; Lemos 2010; Mann 2004a; Mann 2005a; Moreno 2004; Murata 2011; O’Hara & Hall 2008; O’Hara, Tuffield & Shadbolt 2009; O’Hara 2010a; O’Hara 2010b; O’Hara 2012; Price 2010a; Price 2010b; Rawassizadeh & Min Tjoa 2010; Rawassizadeh 2011; Sonvilla-Weiss 2008; Sweeney 2004; Van den Eede 2011). Then we changed the term “ethic” to “moral”, which yielded 1 used source (Van Dijck 2012) and “moral” to “normative”, which yielded no sources that met our criteria. For the next queries, we conducted the same searches only replacing “lifelog” with “MyLifeBits”, “MyLifeBits” with “SenseCam” and “SenseCam” with “cyborglog” and combined each of these terms with “ethic”, “moral” and “normative” as described in the first search. The last search replaced both “cyborglog” and “normative” with “Steve Mann” and “lifelog”. The results are listed in Table I which lists the number of results yielded by a search term under ‘total’, the number of results which did not occur in previous queries under ‘new’, and the sources which are used in this literature review under ‘useful’.⁷

Query	Total	New	Useful
Lifelog ethic	348	-	30
Lifelog moral	96	38	1
Lifelog normative	96	35	-
MyLifeBits ethic	159	84	4
MyLifeBits moral	69	15	3
MyLifeBits normative	20	5	-
SenseCam ethic	194	96	1
SenseCam moral	76	19	-
SenseCam normative	45	15	-
Cyborglog ethic	28	18	2
Cyborglog moral	15	3	-
Cyborglog normative	4	-	-
Steve Mann lifelog	98	55	4

⁵ As for the large amount of sources not included, this has various reasons of which a few examples will be provided: the term ‘lifelog’ used in the source signifies a radically different technology such as a weblog; there is a reference made in the source to lifelog devices or projects but these are not the focus of inquiry; sources can mention the existence of ethical issues only to mention that those do not fall within the scope of their research; applications to Research Ethics Committees as a formal procedure are mentioned but ethical concerns are not discussed; or the terms ‘life’ and ‘log’ appear closely together in the texts without mentioning the technology leading to *false positives*.

⁶ We use the term ‘ethic’ instead of ‘ethics’ or ‘ethical’ to include variations on ethic such as ethical and ethics. The same applies for the term ‘moral’, which also includes variations such as morality and morals.

⁷ We acknowledge that our literature review may not exhaustively include all sources on the ethical debate on lifelogs. Our literature review differs from studies such as the one undertaken by Heersmink et al. 2011 that provide an insight into the relations between key terms in the field of computer and information ethics as mentioned in particular databases using software. Their endeavour provided the academic field with an insight into the frequency in which combinations of terms occur in selected journals. A disadvantage of this approach is that one obtains very little insight into the debate except for the terms used. Our aim is to provide a more in-depth insight by providing references to specific sources and by briefly explaining the core of their arguments. This way, researchers can use our literature review to find sources which point them to challenges and opportunities. Unfortunately, this approach is more demanding leaving it unfeasible to incorporate a plenitude of search terms as they were included by Heersmink et al 2011. Therefore we have excluded terms such as ‘privacy’, ‘surveillance’, ‘autonomy’. In addition, we want to stress that by limiting research to particular databases and journals, one can never be sure to have included all important sources. This applies equally to us as to Heersmink et al. 2011. This concern can be somewhat alleviated through the method of snowballing as influential articles would often be referred to by others. More importantly, the aim of this research is not necessarily to gather all relevant sources. We aim to set an

The first queries, “lifelog” and “ethic”, “moral” and “normative” are self-explanatory. The second term “MyLifeBits” was chosen because MyLifeBits was an early and pivotal lifelog project. Gordon Bell, who was the subject of this research, coined the term ‘lifelog’. The query “MyLifeBits” and “ethic” provided 4 used sources (Bannon 2006; Bannon 2011; Curry 2007; Turkle 2011) and the query “MyLifeBits” and “moral,” 3 (Hall, Johansson & de Léon 2013; Katz & Gandel 2008; Lahlou 2008). This third term, “SenseCam,” was chosen because the SenseCam is one of the first devices designed especially for lifelogging and worn by prolific researchers such as Gordon Bell and Cathal Gurrin. The query “SenseCam” “Ethic” only yielded one result (Weber 2010). The fourth term “cyborglog” has been chosen because of the importance of Steve Mann, considered a pioneer of lifelog technology. The terms ‘cyborglog’ or ‘lifeglog’, are the terms he uses for technology similar to lifelogs. The term “cyborglog” “ethic” yielded 2 usable results (Mann 2005b; Mann, Fung & Lo 2006) The terms “Steve Mann” and “lifelog” have been chosen as the term “cyborglog” seemed less commonly accepted as “lifelog”. This yielded 4 results which were used in this literature review (Mann 2004b; Nack 2007; Sellen & Whittaker 2010; Werkhoven 2005). Before we started this endeavour, we identified the main project, names and technologies. By choosing the most prominent projects, names and technologies within lifelogging, we hoped to provide an overview of the current academic debate which can be used as an instrument to further the ethical debate. All those queries were conducted on the 8th and 9th of April 2013. Snowballing yielded 7 further results (Bailey & Kerr 2007; Bell & Gemmell 2009; Cheng, Golubchik & Kay 2004; Dijck 2005; O’Hara et al. 2006; Smith, O’Hara & Lewis 2011; Turkle 2008).

3. Results

The searches resulted in 52 relevant sources (23 journal articles, 11 book chapters, 8 conference papers, 6 workshop papers, 1 book, 1 column – in a scientific journal –, 1 talk, and 1 working paper) after discounting the overlapping entries. Table II shows the sources and their year of publication.

The debate got started by the aforementioned DARPA project ‘Lifelog’ (Moreno 2004; Sweeney 2004) and the researchers Mann and Bell (Mann 2004a; Mann 2004b; Cheng, Golubchik & Kay 2004).⁸

3.1. Challenges

We distinguished 8 challenges from this accumulated literature (see Table III), which we will elaborate on in decreasing order of frequency of occurrence in the academic debate.

3.1.1. Infringements on privacy

Lifelogs are said to be detrimental to privacy. However, privacy is often ill-defined or not defined at all, making it puzzling what they mean by the term ‘privacy’. This is arguably the case in the following sources: Byrne, Kelly & Jones 2010; Cheng, Golubchik & Kay 2004; Del Giudice & Gardner 2009; Price 2010a; Price 2010b; Sweeney 2004; Rawassizadeh & Min Tjoa 2010; Rawassizadeh 2011; Smith, O’Hara & Lewis 2011; Werkhoven 2005. Most sources suppose an intuitive idea of privacy as the control over personal information. Some have explicated their concept of privacy (Allen 2008; Mann 2005a; Jayaram 2011). Others aimed to redirect a

Year	Sources
2004	5
2005	5
2006	3
2007	5
2008	6
2009	3
2010	8
2011	10
2012	4
2013	4

Table II

Challenge	Occurrence
Privacy	26
Deleterious influences on perception	18
Shortcomings technology	16
Impeding forgetting	13
Uncertainties	12
Impairing social interaction	7
Psychological and Health risks	5
Issues concerning the protection of research subjects	3

Table III

agenda both for engineers as they may become aware of ethical issues previously unknown to them and for ethicists as they may discover underdeveloped areas within the current debate.

⁸ Cheng, Golubchik & Kay (2004) took part in the CARPE 2004 workshop chaired by Jim Gemmell, who is a partner of Bell on the MyLifeBits project.

misconception about privacy with regard to lifelogs.⁹ Others offer an elaborate discussion in order to offer recommendations for developers (Lahlou 2008).

If we consider privacy at least to be influenced by control and access of personal information and monitoring, consent should be considered a related challenge. There are consent issues which have been mostly addressed without explicitly mentioning consent.¹⁰ The non-consensual logging of third parties is an obvious challenge (Allen 2008; Bailey & Kerr 2007; Cheng, Golubchik & Kay 2004; Del Giudice & Gardner 2009; O'Hara 2010a; O'Hara 2012; Sonvilla-Weiss 2008). It might become impossible to stay off the grid (Sonvilla-Weiss 2008). Another issue is the freedom to choose to keep a lifelog. There might be considerable societal pressure to keep a lifelog (Allen 2008; O'Hara 2010a; O'Hara 2012). A lifelog could become a prerequisite to show good intentions, since the absence of a lifelog could be interpreted as signifying the intention of hiding malign behaviour. Also, the consequences of sharing information are unclear. Although one might be able to choose the information one wants to share, one has little influence in how self-publicized information is used and interpreted (Bailey & Kerr 2007; Murata 2011). For example, videos can be edited to use only certain parts. Also one has little insight into the retention and functioning of the data.

Another related challenge is surveillance. The relation between citizens and authorities or companies may be affected by lifelogs as they could be a source of information for states (Allen 2008; Bailey & Kerr 2007; Del Giudice & Gardner 2009; Dodge & Kitchin 2007; Lemos 2010; Moreno 2004; O'Hara, Tuffield & Shadbolt 2009; Rawassizadeh & Min Tjoa 2010; Rawassizadeh 2011; Sonvilla-Weiss 2008; Weber 2010). Consequently, citizens are vulnerable to pernicious surveillance by either governmental institutions or corporations (Bailey & Kerr 2007; Del Giudice & Gardner 2009; Dodge & Kitchin 2007; Rawassizadeh & Min Tjoa 2010; Rawassizadeh 2011; Sonvilla-Weiss 2008; Weber 2010). Indeed, by using lifelogs citizens can be turned into recreational spies as well as revealing confidential information (Allen 2008; Dodge & Kitchin 2007). Recreational spies, meaning people who investigate without it being their profession, might have little awareness of the legal and moral interests of their target and lack the professional ethics which professional investigators are assumed to possess (Allen 2008, p. 20).

3.1.2. Deleterious influences on perception

Lifelogs have been ascribed a potentially deleterious influence on our perception of the past, our memories, and the present, with three specific examples.¹¹ Firstly, there is a blurring of past and present. The longevity of digitized information renders information about the past as readily available as information of the present. Consequently the past will be judged with standards of the present and vice versa (Allen 2008; O'Hara 2010a; O'Hara 2010b; Rawassizadeh & Min Tjoa 2010; Rawassizadeh 2011). A related challenge is the amount of information created: trivial data might marginalize important information (Allen 2008; Katz & Gandel 2008). The source of information changes as well. Lifelogs produce information without a social community (Curry 2007). This will extend a solipsistic view of the world and oneself. Moreover, lifelogs might lead to epistemological uncertainties because data are easily manipulated and therefore not always to be trusted (O'Hara et al. 2006; O'Hara 2010b; Weber 2010).

Second, lifelogs have difficulties capturing subjective experiences and are able to capture only concrete information. This might limit the interest for subjective interpretations. Therefore, in memories, values such as truth might become overstated, narrowing the use of memory (O'Hara 2010a; O'Hara 2012; Dib 2008; Van Dijck 2005; Van Dijck 2012). For instance, memories are also relevant to the composition of identity (Dib 2008). By leaving the archiving of information to devices, we affect our control over personal information and the way we perceive ourselves and others. An additional challenge is one's assessment of past behaviour.

⁹ Kang et al. (2011) explicitly had a privacy account which has control as a central value. Some considered privacy a public good instead of an individual interest (O'Hara et al. 2006; O'Hara, Tuffield & Shadbolt 2009; O'Hara 2010a; O'Hara 2012). Bailey & Kerr (2007) tried to redress the idea of privacy as an individual interest trumped by waivers and consents.

¹⁰ Bailey & Kerr 2007 mention it explicitly as they consider the lack of clarity of the consequences of sharing information.

¹¹ Sources mentioning challenges within this category are: Allen 2008; Bannon 2011; Curry 2007; Del Giudice & Gardner 2009; Nack 2005; O'Hara et al. 2006; O'Hara 2010a; O'Hara 2010b; O'Hara 2012; Rawassizadeh & Min Tjoa 2010; Rawassizadeh 2011; Sonvilla-Weiss 2008; Turkle 2011; Weber 2010

Lifelogs provide retrospection to decisions made in the past. However, the right decision might be more obvious in hindsight with lifelog information than it was at the time, leading to callous judgements about the past (Bannon 2011; Del Giudice & Gardner 2009; O'Hara 2010a; O'Hara 2012).

Third, lifelogs could influence one's perception of the present. A loss of interest in information that cannot be archived in a lifelog could occur (Turkle 2008; Turkle 2011). Also, lifelogs might have a similar effect on perception as the photo camera, which made people look at reality as potential photo opportunities (Van Dijck 2005). Even our existence could be affected; the ability to obtain information from anywhere at any time and the source of information, could change people's understanding of being present (Weber 2010). This challenge is based on the idea that our perception of the world is based on information rather than objective facts (Weber 2010). Lifelog technology would change information and therefore possibly our perception.

3.1.3. Shortcomings of the technology

The functioning of lifelogging technologies has been questioned. Some of these challenges are practical, such as the inconvenience of wearing devices; unintentional lifelogging (i.e. lifelogging without being aware that one is lifelogging); the distress caused by the loss of data; the practical limitations of the devices; the inconveniences imposed on others of knowing that they are being recorded (Bell & Gemmell 2009; Byrne, Kelly & Jones 2010; Mann 2004a; Rawassizadeh & Min Tjoa 2010; Rawassizadeh 2011). O'Hara (2010a) argued against these challenges stating that if the technology does not function according to standards, people will refrain from using it. Thus, these challenges will only be an issue for developers and not of significant ethical concern.

However, there are other, more intricate challenges. One of them is that lifelogs might be unable to capture relevant information. The physical world is too complex for all aspects of reality to be measured. Therefore, lifelogs gather only bits of information instead of providing an integrated overview of reality (Curry 2007; Del Giudice & Gardner 2009). Lifelogs are said to be intrinsically limited in capturing information (Dodge & Kitchin 2007). They only gather empirical information; they are unable to capture subjective experience. Other sources also mention the impossibility of capturing context in which information gets its meaning (Bannon 2011; Del Giudice & Gardner 2009).

In addition, the idea of 'memory retrieval' is questioned (Bannon 2006; Curry 2007; Moreno 2004; Nack 2005; Sellen & Whittaker 2010; Van Dijck 2005; Van Dijck 2012). Memories are dissimilar to data, as they are subjective revisions of the past. In contrast to a photo which is taken once at a certain point in time, a memory is constructed whenever it is prompted. This process differs at given times, hence the memory changes. Correspondingly, 'the sharing of experiences' seems equally farfetched: because experiences are subjective interpretations the genuine sharing of any experience might be/is impossible (Del Giudice & Gardner 2009). In contrast, some consider the ability of lifelogs to mirror reality of lesser importance than their effect on [perceptions of] representation and temporality, because an absolute distinction between objective reality and subjective interpretation is troublesome (Dib 2012).

3.1.4. Impeding forgetting

The desirability of one of the objectives of lifelogs, namely the capturing of events of a person's life, can be questioned because forgetting can be important (Allen 2008; Bannon 2006; Bannon 2011; Byrne, Kelly & Jones 2010; Clowes 2012; Dodge & Kitchin 2007; Dodge 2007; Koops 2011; Murata 2011; Nack 2005; Sonvilla-Weiss 2008; Van Den Eede 2011; Van Dijck 2012). There are various reasons identified to support this line of thinking. One is the 'clean slate' argument: It should be possible to forget the past to allow persons to move beyond their past deeds (Koops 2011). This also has positive societal effects. For example, expunging records, such as financial and criminal records, can have a positive effect on productivity as they limit one's eligibility for loans and jobs. Secondly, forgetting aids self-development because people should be able to change their opinions without this change being held against them (Koops 2011). In a broader sense, people could feel limited by the constant awareness of the possibility of their deeds being remembered at all times (Koops 2011). Thirdly, the recalling of events could impair reconciliation between people. Again this has societal implications as shown in South Africa with the establishment of the Truth and Reconciliation Commission in 1995 after

Apartheid (Bannon 2006). Fourthly, non-forgetting might not be the enhancement one would hope for; the influx of memories could render one apathetic while the details obscure one's potential for abstract thought (O'Hara 2010a). Also forgetting is an intrinsic part in controlling one's memory. Lifelogs would trigger memories one would prefer were forgotten (Murata 2011). Subsequently, one loses control of one's life story as one cannot choose what to forget (Clowes 2012; Murata 2011). After all, one is unable to choose which information is used and which left unused. Finally, non-forgetting could hinder intellectual growth. Data of past behaviour might be used to personalize services which might be based on previous behaviour (Murata 2011). By doing so, they confirm and/or establish past and/or current behaviour. A final critique is more abstract. It holds that biological and technological memory are interwoven making it difficult to separate them. Moreover, both storing *and* deleting personal information, i.e. remembering or forgetting, will have an intricate effect both good as well as harmful on an individual's memory and society which we may not always notice (Van den Eede 2011). Therefore we have to critically assess both the merits of remembering/storing and forgetting/deleting.

3.1.5. Uncertainties

The current early developmental stage of lifelog evolution poses challenges because there are variables which limit our ability to assess the consequences of the technology once it is used by individuals. The inability to completely legally regulate the technology before it has fully developed is an example of such a challenge. Thus, it remains unclear how stakeholders, such as companies, authorities, or fellow citizens, are legitimately allowed to use the technology (Allen 2008; Bell & Gemmell 2009; Cheng, Golubchik & Kay 2004; Dodge 2007; Bailey & Kerr 2007; Del Giudice & Gardner 2009; Koops 2011). The uncertainty about regulation also obscures the functioning of a technology in society (Bailey & Kerr 2007). There are further reasons why the functioning of a lifelog is uncertain: the control one has over the functioning of a lifelog and the information it produces (Bailey & Kerr 2007; Dodge & Kitchin 2007; Dodge 2007); the influence of a lifelog on identity (O'Hara 2010b; Clowes 2012; Moreno 2004); the interplay between biological memory and the lifelog (Clowes 2012). These variables can pose challenges to users and developers, but as yet it is uncertain if they will.

3.1.6. Impairing social interaction

Social interaction can be negatively affected by lifelogs (Allen 2008; Bell & Gemmell 2009; Murata 2011; O'Hara et al. 2006; O'Hara, Tuffield & Shadbolt 2009; O'Hara 2010b; Sonvilla-Weiss 2007). The disappearance of face-to-face encounters, i.e. the disappearance of a physical human presence in obtaining and spreading information has to be faced (O'Hara et al. 2006; O'Hara, Tuffield & Shadbolt 2009; O'Hara 2010b). Moreover, as mentioned, lifelogs could hinder social forgetfulness and thereby impair social bonds (Allen 2008; Murata 2011). Lifelogs will affect our set of social norms to the extent that it is likely it will require a redefinition of norms (Bell & Gemmell 2009; Sonvilla-Weiss 2008). A further challenge is that lifelogs lead to a decrease in particular human emotions when dealing with others. People might become more dependent on lifelogs to memorize. In order to memorize, a lifelog will retrieve information without a social context or subjective experience. This loss might affect social interaction as this information is conveyed without human emotions as compassion and empathy. As a result, society as a whole could develop characteristics similar to autism or schizophrenia because they use this dehumanized information for interaction (Murata 2011). Finally, the disappearance of others and the replacement by lifelogs as the source of information, which leaves less space for subjective interpretations, might influence one's identity (Murata 2011). The result is that lifelogs can affect or change who one is.

3.1.7. Psychological and health risks

Lifelogs have been ascribed possible negative effects on health. Some mention cognitive laziness (Del Giudice & Gardner 2009): people will not use their own memory but rather rely on their lifelogs. This could harm the capacity to remember. The human brain is malleable, it adjusts to external conditions. When parts of the brain are left unused they might lose their functionality. This way, an artificial memory is not necessarily an enhancement of the brain, because it could possibly reduce biological memory (Murata 2011). In addition, a technological rather than a biologically or socially constructed personal identity or awareness of the self might

lead to autism or schizophrenia (Murata 2011). Another challenge is a lifelog being the cause of pathological rumination by facilitating ponderings for sufferers from bipolar and unipolar depression (Allen 2008; Rawassizadeh & Min Tjoa 2010; Rawassizadeh 2011). Also, the recalling of events can be harmful. If, for example, a memory of the event that led to a post-traumatic stress disorder were carelessly evoked, it could lead to a deterioration of the disorder (Allen 2008).

3.1.8. Issues concerning the protection of research subjects

‘The protection of research subjects’ is the only challenge that takes trials into account (Byrne, Kelly & Jones 2010; Price 2010b; Kelly et al. 2013; Sweeney 2004). This challenge has not been elaborated except in Kelly et al. (2013) who discuss an ethical framework for doing trials with wearable cameras. The advance an elaborate account of ethical challenges brought forward by lifelogging. The other sources only mention the problem without specifying them.

3.2. Opportunities

Table IV shows the number of sources from our literature survey which identify a particular opportunity. We distinguished 6 opportunities which we will elaborate on in decreasing order of frequency in which they occur in the academic debate. The difference between the number of challenges (101) and opportunities (30) is not necessarily an indication of widespread adversity towards the further development of the field. In fact, some challenges are identified to streamline the development and integration. Smith, O’Hara & Lewis (2011), for example, identify more challenges than opportunities although they propose lifelog software.

Opportunities	Occurrence
Citizen Empowerment	10
Personalized services	8
Valuable information	6
Health benefits	3
Behaviour modification	4
Shaping identity	1

Table IV

3.2.1. Citizen empowerment

Lifelogs may empower citizens against undesirable behaviour of the authorities. The sources invariably mention sousveillance: citizens monitoring the authorities (Allen 2008; Bell & Gemmell 2009; Mann 2004a; Mann 2004b; Mann 2005a; Mann 2005b; Mann, Fung & Lo 2006; O’Hara, Tuffield & Shadbolt 2009; Rawassizadeh 2011; Weber 2010). Sousveillance is a reversal of surveillance in which the authorities watch citizens. Mann, who coined the term, broadly interprets it as both the secret taping of police brutality as well as questionnaires from the management handed to shoppers about their staff (Mann 2002). This latter example is in-band sousveillance and organized within an organization. Relevant to lifelogs is out-of-band sousveillance. This is sousveillance by people outside the organisation. Lifelogs could record the behaviour of the authorities. These records can be shared. This way, the authorities are better controlled, because behaviour by officials is increasingly made visible.

Equiveillance, balancing surveillance and sousveillance, is another opportunity identified by Mann. This concept seems to entail that the adverse effects of surveillance would be cancelled out by sousveillance (Mann 2004a). A related opportunity is the ability to provide information about one’s innocence to the authorities to refute accusations (O’Hara, Tuffield & Shadbolt 2009).

3.2.2. Personalized services

By using lifelogs, data software can be developed to increasingly accommodate the needs of specific users or groups, such as aids to memory, information retrieval, recommendation systems, educational tools, research tools, policy information, organisational information, information for historical studies (Bell & Gemmell 2009; Kang et al. 2011; Mann 2004a; Mann 2004b; Mann 2005a; Mann, Fung & Lo 2006; O’Hara, Tuffield & Shadbolt 2009; Rawassizadeh 2011).

3.2.3. Valuable (non medical) insights

Lifelogs offer valuable information as well as valuable emotional information (Allen 2008; Bell & Gemmell 2009; Kang et al. 2011; Mann 2004b; Nack 2005). Lifelog data can serve to reflect on oneself or society as a whole, thereby gaining deeper personal or collective understanding. Increased self-understanding by lifelog information can positively influence self-control (Hall, Johansson & de Léon 2013). Mann (2004b) considers lifelogs to have artistic potential producing art and culture. Finally, the development of lifelog technology itself could also provide valuable information as it incites a rethinking on what constitutes a human being (Nack 2005). Also, it could gather or conserve emotionally valuable information about a loved one (Bell & Gemmell 2009).

3.2.4. Health benefits

Lifelogs might benefit health or improve medical practice. A case in point is the improvement of therapeutic tools (Allen 2008; Bell & Gemmell 2009; O'Hara, Tuffield & Shadbolt 2009). The ability to measure the patient's behaviour could lead to better diagnoses, improved therapies and beneficial lifestyle changes (Bell & Gemmell 2009). Another opportunity is telemedicine (O'Hara, Tuffield & Shadbolt 2009). Physiological signals do not necessarily have to be measured in the hospital, which makes it possible to provide some medical assistance from a distance, thereby enhancing patients' independence (O'Hara, Tuffield & Shadbolt 2009). Moreover, the vast amount of information one might collect from subjects could be used to improve medical studies (Bell & Gemmell 2009).

3.2.5. Behaviour modification

By increasing knowledge about their behaviour and feeding back this knowledge which is derived from lifelogs, people may improve their performance at some task (Rawassizadeh 2011) or change their behaviour to their benefit. Also, lifelogs could play a role in the prevention of criminal behaviour. The threat of being visible may make criminals think twice before committing a crime (Allen 2008; Bell & Gemmell 2009). There is also a more abstract discussion about the interplay between organic memory and artificial memories in the sense of lifelogs in which it is suggested that lifelogs may extend the mind i.e. lifelogs would be considered a part of the human mind (Clowes 2013). This may be defined as a phenomenological position on lifelogs.

3.2.6. Control of identity

Identities can be constructed and imposed more easily as a consequence of using lifelogs. Some are constructed formally by authorities such as one's financial profile or identity card data and some informally by, for example, a friend's views as to one's trustworthiness. The concept of identity, as used by O'Hara, Tuffield & Shadbolt 2009, in this sense is quite thin. It consists of certain properties and characteristics ascribed to the individual by another entity which can use this information. A lifelogger has more control over those externally imposed identities. The lifelogger could have a vast database of information which could be used to create a new identity or to oppose identities that have been ascribed to oneself by others. Without lifelogs, one would have less information at one's disposal to do this (O'Hara, Tuffield & Shadbolt 2009).

4. Discussion

As the results section showed, the debate around ethical issues offers an interesting discussion on a rich variety of challenges and opportunities concerning lifelogs. However, there remain important ethical elements, which have been neglected in the literature so far and need further analysis. For one, the variety of goals, sources of data, and users of lifelogging has not yet been accounted for in the current ethical debate. There is a need to reassess the challenges and opportunities with regard to specific goals, devices and users because the various domains of application and devices trigger idiosyncratic challenges and opportunities. Hence, some of the already identified challenges and opportunities are not applicable or have different weight in a particular context. Others have not yet been identified. For instance, there is no reference to the self-surveillance of soldiers or other officials in the current literature, even though programs such as the aforementioned DARPA project ASSIST or LifeLog show a clear interest in lifelogs by governmental authorities. Also, there is little written about the challenges and opportunities that occur when corporations are entitled to hold or access

lifelogs.¹² This is noteworthy as the history of lifelogs demonstrates that companies have a strong interest in holding vast amounts of information about individual people. This poses various challenges and/or benefits as corporations and governmental institutions exert real influence. Unfortunately the assessment of the weight of the various challenges and opportunities covering most domains of use falls outside the scope of one article. In order to discuss the weight of the challenges and opportunities for these domains, we first have to clarify the concept of lifelogs and lifelogging and identify the potential goals and users. Secondly, we will show that challenges and opportunities have different weight when lifelogs are applied in different contexts. Thirdly, we provide our own ethical analysis. We focus on one specific domain, namely lifelogs used by consumers for reasons affecting lifestyle. One challenge particular to this domain is discussed which has been underdeveloped in the discussion is the choice of keeping lifelogs. Finally we will present a general approach to alleviate concerns with the choice of keeping lifelogs.

4.1. The goals of lifelogging

A lifelog provides an insight into a person's life. There are various goals for lifelogs. Dodge & Kitchin (2007) call the functioning of a lifelog "autobiographical" (p.7) but this is confusing as it is the lifelog and not the users that provide meaning and significance to data by processing data into information. Rather, a lifelog provides access to a 'history' or 'biography' of the parts of a person's life that are lifellogged. In this sense, the lifelog is commissioned rather than written by the individual. Another common metaphor is something in the manner of lifelogs as a "portable, infallible, artificial memory" (Bell & Gemmell 2007) but this metaphor has its flaws. The information a lifelog contains can surpass the information one obtains through experience. For instance, identification software can recognize people in photos whom you did not notice at the time, GPS and WiFi can track distances more accurately than a person's guess, and a heart rate monitor can measure heart beats. Some of this information goes beyond our perception let alone what we can remember. In addition, the information stored is only associated with a particular part of the memory as they contain solely quantifiable information. Also, the kind of information a lifelog can contain is limited as discussed in section 3.1.2.

The particular goals of a lifelog are manifold. Moreover, different agents will have diverse motivations to use the lifelog, e.g. medical institutions use lifelog services for different reasons than an individual consumer. The following examples demonstrate this:

- I. Lifelogs can be used to benefit health or improve medical practice. Some authors considered lifelogs or specific lifelog devices to have the potential to serve as a therapeutic tool (Allen 2008; Bell & Gemmell 2009; O'Hara, Tuffield & Shadbolt 2009). The SenseCam, for example, can serve as a mnemonic device to support patients at an early stage of dementia (Piasek, Irving & Smeaton 2011).
- II. The use can be corporate: This can have productivity goals. By increasing knowledge about the behaviour of employees and feeding back this knowledge, employees may improve their performance at some task or they may even improve by the knowledge of being monitored (Rawassizadeh 2011). Also corporations can reap safety and security benefits as the following of procedures and caring for the self can be an instrument for the well-being of the employees. Corporations will be better able to target and tempt customers by using their lifelogging information.
- III. Governmental institutions could profit from lifelogs either because lifelogs provide them with more information about citizens which was the case with the DARPA LifeLog project (DARPA IPTO) or they can equip soldiers with lifelogs as is the case with the soldier body suits which are aimed to provide digital memories from the battlefield (Schlenoff, Weiss & Steves 2011, Shachtman 2004).
- IV. Individuals could also choose to create a lifelog for many different reasons: they feel a personal need to create a lifelog: they might enjoy the activity of lifelogging or the information they obtain from the lifelog;

¹² Only Jayaram (2011) stresses the importance of privacy for businesses. Murata (2011) considers the issues with intellectual growth as companies have that much information to confirm previously established information. Del Giudice & Gardner (2009) consider the distance between management and staff if lifelogs are used. Others only briefly mention surveillance without much elaboration: Bailey & Kerr 2007; Del Giudice & Gardner 2009; Dodge & Kitchin 2007; Rawassizadeh & Min Tjoa 2010; Rawassizadeh 2011; Sonvilla-Weiss 2008; Weber 2010.

they feel that a lifelog is a requirement to participate in their social community; they are just curious. The Memoto is marketed to these people.¹³

4.1.1. Users of lifelogs

As there are many potential goals, also there exists a variety of potential users for which lifelogs are designed. Our working definition left these undefined. We can distinguish at least 4 different kinds of users for which a lifelog can be designed:

- I. **Private individuals:** Individuals can create a lifelog about themselves. This seems to be the most discussed form of a lifelog within the ethical debate about lifelogs.
- II. **Corporations:** Corporations are ignored as potential users of lifelogs in the current academic debate on the ethics of lifelogs. However, they might be the main users of lifelogs via equipping employees with lifelog devices. Currently, Stanford University is developing a *life archive*, which seems like a lifelog, about William McDonough's working life as a sustainable architect (Flemin 2013).
- III. **Public institutions:** Public institutions can also use lifelogs by providing patients with lifelog equipment. Medical institutions may use lifelogs as some treatments and therapies can improve or depend on monitoring the patients. There is already work done on lifelogs for dementia patients. Also universities could use lifelogs as an instrument to obtain data for all kinds of research or advance their technological abilities.
- IV. **Governmental organizations:** Despite DARPA's LifeLog project and DARPA's ASSIST project, governmental organizations are mostly neglected as potential users. For example, lifelogs could be beneficial when deployed to monitor soldiers in battle.

4.1.2. Sources of data

Finally, we can provide some clarity into the nature of the devices used to lifelog. There is a broad range of devices which can be (made) suitable for lifelogs. Whilst the ethical relevance may not be immediately clear, this distinction is ethically relevant because the devices will trigger different ethical concerns as the manner as well as the information that is obtained is relevant. Unfortunately an overview of all devices cannot be given as future development leaves open the exact devices which will be used. Nonetheless, we are able to identify the general characteristics of these devices:

- I. **Wearable devices:** Wearable devices are devices that function while carried on the body. Memoto, ZEO – a device that measures sleep quality –, and the SenseCam are wearable.
 - a. **Inward facing devices:** These wearable devices measure and capture physical conditions of the individual such as heart rate, glucose levels, and bodily temperature.
 - i. **Implantable sensor devices:** A particular subset of these devices is invasive, i.e. they are in the body. This has ethical relevance especially if lifelogs are required by third parties such as governments or corporations as this could mean that the bodily integrity of a person is violated. An example of such a device would be a subcutaneous sensor device which measures glucose using blood samples.
 - b. **Outward facing devices:** These devices measure capture physical conditions about the environment instead of the individual. Examples are the SenseCam and Memoto capturing the environment in which the individual is situated rather than the individual (even though the SenseCam is also able to sense bodily health which makes it somewhat of a crossover between inward and outward facing).

¹³ Chen and Jones (2012) have examined the reasons that result in the motivations for lifelogging by private individuals. According to their research people want to: “re-live the remote or recent past”; “memory backup”; “telling and passing life stories”; “re-use”; “evidences”; “collection and archiving”; and “learning about unknown early age” (Chen & Jones 2012).

- c. Online activities: Not all data are captured by sensors that measure physical conditions. Some of the data are about digital activities. These data include amongst others visited websites, emails and can be sourced from any wearable device which allows one to participate in the digital realm.
- II. **Environmentally embedded devices**: These devices are embedded in the environment in which the person is situated rather than worn by the individual. Examples of such devices are energy usage meters, smart televisions or magnetic stripe cards holders when entering a room or building.
 - a. Online activities: Same as above. Examples of devices are desktop computers or smart televisions.
- III. **Third party information**: Some data are obtained from third parties. Various different third parties could provide information about the individual, such as financial or health institutions.

4.1.3. Weighing challenges and opportunities

Challenges and opportunities weight differently depending on the goal, device and use. It is outside the scope of this article to assess the weight of all challenges and opportunities in all potential domains of use. We will briefly provide two challenges to show the importance of context.

- I. **Privacy**: If we compare issues with privacy for the use of lifelogs by private consumers for reasons affecting lifestyle with lifelogs worn by soldiers and deployed by the military to obtain information about the battlefield, we encounter ethically relevant differences. For one, third party access for lifelogs used by the military is not an undesirable side effect; indeed, it is the reason why these lifelogs are developed. In case of lifelogs held by private consumers, access by third parties such as authorities requires further justification, for example, reasonable suspicion of criminal activity. Second, control over information by the subject of the lifelog is of lesser importance in the case of military use than for private individuals. Lifelogs for soldiers would be part of their professional routine rather than a technology where use is free of commitment. Indeed, it might be crucial for the functioning of the lifelog that the soldier cannot temper with information as the military might require highly reliable and comprehensive information whilst citizens may reasonably demand more control for ethical reasons. Third, the issues with outwards facing devices are altered as the soldiers on the battlefield will be in situations in which their counterparts will be aware of being lifelogs and will probably be lifelogging themselves. Moreover, in the case of military use, lifelogs can protect the people being logged as the lifelog can be used to scrutinize the behaviour of soldiers requiring the soldiers to uphold the right standard of conduct.
- II. **Impairing social interaction**: As we have mentioned, a challenge identified with regard to lifelogs is that social interaction can be negatively affected by lifelogs. When we compare lifelogs to aid persons with dementia in obtaining some information about their daily goings-on with private or corporate use of lifelogs, this challenge has little or no weight to the former while some weight to the latter two. Persons with dementia may feel they gain more control over their lives if they can review events while you can hardly argue that these lifelogs diminish their ability to socially interact. However, if we consider lifelogs for private individuals or corporations then this issue gains more importance. If lifelogging devices worn by employees are used for managerial decisions, this could potentially silence the employee as information would increasingly be obtained from the device. We have already discussed the potential effects on individuals. Importantly, these ethically relevant differences demand specific approaches to alleviate ethical concerns and reap the benefits.

4.2. The choice of keeping lifelogs

Unfortunately, due to the variety of possible lifelog applications, it is impossible to address all issues of lifelogs within every possible domain. For this reason, we decided to narrow our discussion to some underdeveloped aspects of the choice of keeping lifelogs with regard to lifelogs for private users for purposes affecting lifestyle. Despite the rich academic debate on these kinds of lifelogs, there are still challenges which need to be identified. Individual consumers may use a lifelog because they enjoy the activity of lifelogging, value its information, or consider lifelogs necessary to participate in society. These lifelogs are not imposed by corporations, authorities or other institutions through rules and regulations. Moreover, there is no immediate professional or medical need

to use the lifelog, which does not rule out that there might be professional and health-related advantages arising from them.

First of all, when discussing private users keeping lifelogs for purposes affecting lifestyle, there remain issues not addressed in the literature we uncovered. We focus on the choice to keep a lifelog as a more comprehensive discussion of all remaining issues would exceed the limitations of an article. We have already addressed informed consent (above), a similar issue, as part of privacy. The choice of keeping lifelogs has implications for values such as privacy that are influenced by the access and control of information about the person. Second, we provide a general approach to alleviate issues relating to the choice of keeping lifelogs. This approach is predominantly applicable to this specific domain of application. If we would consider other domains, such as lifelogs for persons with dementia or for soldiers on the battlefield, an altogether different approach might be required.

With regard to the choice of keeping lifelogs in this domain of application, we first focus on the information available from keeping lifelogs, which could profoundly impact our daily lives. Against this backdrop, we explore concerns about lifelogs kept by persons with reduced competence. Finally, we discuss the voluntariness of holding lifelogs.

4.2.1. Impact of information available from keeping lifelogs

To inform the holder of a lifelog about the kind of data stored and the parties that can access that data in the lifelog may prove difficult. As the access to lifelog data can negatively affect values such as one's privacy and liberty, clarity about access is important.¹⁴ There are various reasons why this challenge is difficult to meet.

Firstly, it is impossible to assess what information can be obtained from data or technology over time. New information might be inferred from existing data by improving learning or retrieval techniques. Subsequently, data, previously considered harmless, could reveal undesirable information. For example, research has indicated that one's sexuality or political convictions can be inferred from a rudimentary source of information, such as (a part of) one's social network.¹⁵ For this reason a distinction between private, sensitive data and public data is insufficient, since it is precisely the feasibility of this distinction which is doubtful.¹⁶ Thus, one is unaware of just how much privacy one has forfeited. This can have real life effects as third party access to information can influence one's opportunities in life, for example, one's chances of employment or personal relationships with others.

Secondly, due to the complexity of lifelogging devices, clarity about data produced or shared is lacking. The smartphone, which seems set to become a pivotal lifelogging device, can serve as an example. It is difficult to both assess which parties can access particular data from a particular smartphone and to assess what data is gathered from that smartphone. This is partly explained by security glitches even experts are unaware of or a lack of openness from developers regarding which information is stored in which files. Apple, for example,

¹⁴ One is uncertain about how much of his/her privacy has been waived leaving one at risk if the data is ineffectively secured, handled sloppily, used for malign purposes, or shared with commercial or surveillant intentions. This concern is heightened if the information depicts a faulty state of affairs or if the information inferred from the data is false.

¹⁵ Even mental states such as mental illnesses or undesirable character traits, such as narcissism and/or social anxiety, can be identified from posts on websites (Fernandez, Levinson & Rodebaugh 2012; Golbeck, Robles & Turner 2011; Mehdizadeh 2010).

¹⁶ We discuss the fact that we cannot be fully informed about the functioning of a technology because the technology evolves. There are other relevant variables that complicate a distinction between public and private information over time. The lifelogger and the environment in which they lifelogs can change. The lifelogger or the person recorded may consider data captured in the past inappropriate and harmful at present. Moreover, the information stored in a lifelog can become outdated. Lifestyles, social positions, behaviour, and beliefs change. Lifeloggers might be unaware of these changes and lifelogs might not capture them. When opportunities to correct this information are lacking, this can lead to incorrect profiles. This proves especially troublesome if information is used or spread by the lifelogger or third parties, such as corporations, governmental institutions, and hackers with nefarious intentions. Moreover, the (symbolic) value of information changes, meaning that information might obtain different and unforeseen connotations over time (Rawassizadeh 2011). Previously accepted or unenforceable yet unhealthy behaviour at an early stage of life might be punished at a later stage, for example, through higher insurance quotes, lowered coverage, or social exclusion.

has been accused of storing location data on the iPhone and iPad (Allan & Warden 2011).¹⁷ In addition, third parties can mediate the functioning of the device. The software and hardware compatible with the smartphone quite effortlessly manipulates the gathering and access of information.¹⁸ Establishing that other parties have or had access is also quite troublesome, because accessing and copying data can leave little or no trail to the common user. Transparency about access to data is an intricate, albeit important, challenge when designing lifelogs as it has an effect on privacy. This is all the more complex as third parties such as governmental institutions, corporations and others could benefit from obscurity. Finally, lifelogs might be integrated into the fabric of everyday life to the extent that its functioning goes unnoticed, as the paradigm of pervasive computing describes. This may leave bystanders but also the users themselves potentially unaware of being lifelogged.

4.2.2. Concerns about lifelogs kept by persons with reduced competence

Competence is the ability to comprehend information provided and deal appropriately with the consequences of decisions based on this information. Some vulnerable groups have a diminished capacity to do just this. Children, for example, are usually considered less able to foresee the consequences of their conduct. Besides, it is questionable how much information on vulnerable individuals should potentially be available to third parties, since this information could be used for malicious purposes, such as extortion. Additionally, from a didactically justified point of view, it might be important for their personal and intellectual growth to make mistakes without those mistakes being recorded and stored indefinitely or important to escape from the idea of being watched at all times.

Nevertheless, lifelogs should not necessarily be limited to technological competent adults, since lifelogs could be beneficial for people with diminished or not yet fully developed competence such as children or young adults or other groups, such as the elderly, with lower rates of technological competence. For example, access to children's lifelogs could be very useful to their carers, who would have an additional instrument to oversee activities of daily living, such as eating habits or online activities, ultimately helping them lead a safe and healthy life. The benefits of lifelogs might be reaped while the harms are limited by carefully selecting the information necessary and by putting it in the appropriate form. For this reason, we call for an assessment of the ethical desirability of various functions of lifelogs for people with various levels of competence to use lifelogs. It is necessary to assess the kind of information and devices that are beneficial for a particular group and the appropriate form in which the information should be presented.

4.2.3. Voluntariness of holding lifelogs

Because the consequences of holding a lifelog can be far-reaching, the voluntariness of keeping a lifelog is important. Societal pressure to keep lifelogs as a sign of innocence has already been mentioned (Allen 2008) and there may however be other forms of societal pressure to keep lifelogs and share information. Firstly, lifelogs could become necessary to guard reciprocity. If only one party in a conversation owns a lifelog even an innocuous chat could be harmful or made harmful by editing when shared by the lifelogger. The lifelogger gains a comparative benefit by having more information than the other. The same applies to institutions which may obtain more information about the individual than the individual itself has. After all, a third party could construct a lifelog of an individual without the individual holding a personal lifelog. This leaves the individual vulnerable to artificially imposed identities.

A second additional form of societal pressure is society commanding the use of lifelogs by embedding them in the social fabric. Lifelogs could raise evidence standards. In a society in which lifelogs are the norm rather than a rarity, one might be expected to be able to hand over more information. Similarly, detailed phone bills or photos with one's partner could serve as proof of a relationship when applying for official documents,

¹⁷ There are numerous examples of devices sharing and gathering information without people's knowledge; these are a random pick: a smartphone taking photos (Chen 2011); a smartphone with serious security issues (Diaz 2008); software sharing information without people's awareness or consent (Thurm & Kane 2010); a smartphone stores whereabouts even when location services are disabled (Valentino-De Vries 2011).

¹⁸ External devices can be added by the user, such as camera lenses, heart monitor gear, and covers. These devices are accompanied by software.

such as citizenship. A related issue is that lifelogs might become necessary to protect oneself against the authorities. For instance, Hasan Elahi currently uses a rudimentary form of a lifelog to protect himself against the authorities after the FBI required him to provide information about his activities following his identification as a potentially dangerous individual (O'Hara, Tuffield & Shadbolt 2009; TED 2011). This usage seems to disregard a fundamental right, namely the presumption of innocence by shifting the burden of proof towards the suspect. The existence of lifelogs could facilitate this erosion of rights by alleviating the burden of creating this information.

4.3. Control

After this short discussion on the choice of whether or not to keep a lifelog, we can propose our own approach to alleviate ethical concerns about the choice to keep a lifelog made by private individuals for reasons affecting lifestyle. We hold that these three ethical challenges can be alleviated by providing users with extensive control over the lifelog to mediate the functioning of a lifelog. It can be viewed as a reaction to proposals to build in forgetting which has been the only abstract approach proposed to alleviate ethical concerns as uncovered in this literature review which has received widespread attention (Allen 2008; Bannon 2006; Dodge & Kitchin 2005; Dodge & Kitchin 2007; Mayer-Schönberger 2009; O'Hara, Tuffield & Shadbolt 2009; O'Hara 2012).

Let us briefly elaborate on the concept of built-in forgetfulness before we discuss our own point of view. Dodge and Kitchin (2005; 2007) were the first to propose a built-in technological variation of biological forgetting. Their account of forgetting, which is based on the imperfections of memory as identified by Schacter (2001), is not solely the omission of information but also imitates remembering incorrectly. Their built-in mechanism for technological forgetting is materialized through techniques such as temporarily blocking information retrieval, tweaking details, and imperfectly recording data while leaving the broader picture intact (Dodge & Kitchin 2005). They assert that by developing software that preserves the main storylines while randomly forgetting more specific information, we would still possess more information due to the lifelog than we would have had without one. The result of incorporating forgetting into the fabric of a lifelog is that we could not be confident that the retrieved information is true or whether elements were left out; forgetting renders information less reliable. This would reduce issues with surveillance and enhance our control over our past (Dodge & Kitchin 2007, 18). We accept that forgetting is contrary to the *raison d'être* of lifelogs (O'Hara, Tuffield & Shadbolt 2009; O'Hara 2012) and that by building in forgetting we would be throwing out the baby with the bath water. However, we do support the premise that it would alleviate some of the ethical concerns discussed in this literature review; hence we propose a different approach albeit along similar lines.

Our solution to alleviate ethical concerns with regard to lifelogs held by private individuals for reasons affecting lifestyle relating to the choice of keeping lifelogs is to maximize user control over lifelogs. This way, we would obtain a similar effect without suffering the same loss of functionality. More importantly, we can alleviate the three challenges regarding the choice of keeping a lifelog mentioned above. When users can choose and manipulate the information within a lifelog with a minimum of effort and skill, it becomes less reliable as important elements could have been changed, deleted or not lifelogged at all. Moreover, these manipulations should be untraceable, as the ability to retrieve these changes would undermine the goal of this feature. By doing so lifelogs would become less useful for society in serving as evidence.¹⁹ We hold that this would even lessen the reliability of lifelog information to the lifeloggers themselves. This assumption is plausible because the changes are made over time, can be numerous, and are likely to become inundated by other data. For instance, we would have to be able to remember manipulated locations, deleted photos, or modified transcripts by heart over a course of years between all other photos, locations and transcripts in order to persuade ourselves that the information is reliable. Moreover, the ability to control what information is and is not logged means that

¹⁹ This approach does undermine the usefulness of lifelogs in terms of sousveillance as this opportunity relies on evidence which becomes less trustworthy. Therefore we have to weigh the worth of sousveillance against the benefits of this approach. We think that this would favour our approach as data such as photos, videos or audio, can already be easily manipulated outside the lifelog while we still consider the wearing of cameras to be some form of sousveillance. Moreover, as Brin (1998, 31) stated, issues with reliability will be alleviated by the fact that in most cases there will not be one camera but multiple cameras.

we are able to curate what information will become part of the lifelog. The fact that lifelogs are a patchwork of stored and manipulated elements of life becomes more apparent. Furthermore, control also involves being informed about the functioning of the lifelog. Only with sufficient information we can control lifelogs. Therefore we have to take into account the competence of the users as well as providing transparency into the functioning of the device. Hence, the three mentioned challenges can be alleviated using this approach.²⁰ An unrelated advantage of this approach is that we do not propose to mimic the imperfections of our own memory.²¹ This begs the awkward position of needing a technological fix to diminish the usability of a lifelog. For these reasons, we recommend that user control of lifelog devices, information, and data should extend to the greatest extent possible and be one of the focus points when designing lifelogs for individual consumers for purposes affecting lifestyle.

4.3.1. Recommendations

This approach can lead to multiple recommendations suitable for lifelogs held by private individuals for reasons affecting lifestyle. Below we have identified ten recommendations which state that we should be able to choose and change the information within a lifelog; be informed about the functioning of the lifelog; be informed appropriately; and be protected from third parties accessing information. These recommendations follow directly from the issues as discussed above and the approach suggested.

As this is not a ‘value in design’-project, the ability to provide detailed recommendations following our approach is being curtailed by a lack of information. Exact design recommendations are untenable when the focus of inquiry is a technology in general instead of a specific lifelog (device). In different contexts, the perceived harms and benefits and the (weight of) ethical norms, varies. Notwithstanding this limitation, it is possible to provide some general recommendations as rules of thumb. These recommendations are neither sufficient nor final as particular technologies require more specific recommendations. This list aims at the development, use, and regulation of lifelog technology by private consumers for reasons of leisure; other goals of lifelogs need other sets of recommendations. For example, lifelogs for memory therapy are more useful when the lifeloggers have little control so that their therapists can rely on their information. Moreover, the patient may want to hide the device for fear of stigmatization as the device may reveal their disease to others. Furthermore, we stress that these recommendations are not meant to thwart innovation. These recommendations provide instruments to establish consumer and societal trust in lifelogs necessary for the adoption of the technology; therefore the recommendations should strengthen innovation in this field. Also for this reason, we should be wary of trading-off ethical considerations for other interests when developing technology. We must avoid shortcutting ethical concerns for short-term benefits. In addition, the recommendations are also not solely solved by technological fixes. Whilst most of these recommendations do require advancements of technology, others are directed to other disciplines. One of the challenges is concerned with the communication of information, which has mostly to do with communication studies and psychology. We consider the development of lifelogs to require an application of a multidisciplinary field of sciences. Finally, the design recommendations are not sufficient to solve the previous issues or address all issues; at most they alleviate the harms. This is certainly not a cure for all the challenges lifelogs pose. Moreover, some recommendations have more significance to particular groups such as competent adults than others such as children.

- I. **Ability to manipulate data:** The lifelogger should be able to manipulate the information contained in the lifelog. This can take different forms. One of them is the ability to correct erroneous information: lifelogs do not only gather and store data but also process these into meaningful and retrievable information. This process can be erroneous and the lifelogger should have the opportunity to correct it as this information

²⁰ An obvious weakness of both approaches is that they provide little control over lifelogs worn by other people. If one would combine lifelog data one would probably be getting a more reliable and detailed picture. This, however, equally applies to both approaches (Allen 2008). However, in favour of both approaches, this combining of lifelogs requires coordinated efforts requiring resources and time lessening its importance for everyday use of citizens which contrary to authorities have lesser resources available to them.

²¹ This is not to say that forgetting is an imperfection *per se*. We agree that forgetting can be beneficial. However, forgetting as a random computerized process cannot be said to have the same function as forgetting by human beings.

may spread to systems and platforms which offer less space for correction.²² Also, the lifelogger should be able to annotate and change information as they may feel this information provides an unfair image of the self or the availability of this information is contrary to his/her conception of appropriateness.

- II. **Ability to remove information:** The lifelogger should be able to remove data and these deletions should not be retrievable. The ability to remove data and information is essential for control. Part of this is that the lifelogger may think that some data or information is or has become inappropriate. When the data are indiscriminately kept or stored in a lifelog, on back-ups, or copied to other databases, this would severely diminish the lifelogger's control over the dataset.
- III. **Control over sources of information:** The lifelogger should be able to stop recording with a minimum of effort. This chiefly concerns devices gathering information on others. Both Memoto and the SenseCam lacked a pause or stop function in their first design and the Memoto (2013) is still lacking this feature. This illustrates that although some recommendations seem obvious, they may not be. In addition, the lifelogger should be able to take off or stop using a lifelog device without any problem. This may be problematic as lifelog devices are likely to become more embedded into the fabric of everyday life. Consider for example the potential revolution of glasses to smart glasses, such as Google Glass. There is a relationship of dependence on these products as people with vision loss need glasses in order to correct their vision. As the lifelogger of the glasses needs them for vision, this favours the wearing of glasses when the choice has to be made between not wearing and wearing.²³ It gives the lifelogger an unfair advantage as it undermines the weight of objections of others.
- IV. **Control over information:** The lifelogger should have the opportunity to determine both the data and information contained in a lifelog to the greatest extent possible. The choice of what information is appropriate for storage is subjective. Depending on the lifelogger, some information may be contrary to religious convictions, may cause embarrassment, or cause anxiety. As there may be some social pressure to keep a lifelog, we should avoid as much as possible that people have to choose between losing all lifelog functionality and the generation of unwanted information. The challenge of determining information is distinct from having the possibility to select data as data can be processed in various ways to create different kinds of information. To offer a simple example, heart rate can both be used to obtain information about stress levels as well as about health, exercise and excitement. Therefore, a heart rate monitor can both be deemed appropriate and inappropriate as a source of data as information about health might be desired while at the same time information about excitement and stress levels may be unwanted. In addition, developments to gather information from existing data or new data sources may lead to novel information being retrievable in a lifelog. Lifeloggers should have a choice if they want this information to appear. Furthermore, lifelogs should only collect the minimum of necessary data. The collection of unnecessary data may enhance the risks of creating undesirable information. By doing so, we also minimize the stakes when needing to trade-off ethical concerns such as privacy for functionality. Finally, we should minimize data about others. Depending on the use of the lifelog we have to assess the importance of gathering information about others and ways to reduce this. For example, by the blurring of people in photos who have not consented to be recorded.
- V. **Informed about data stored:** The lifelogger should be informed about the data stored by lifelogs and the information obtained from lifelogs. A lifelog should provide optimal transparency of what data and information it contains. Any attempts to obscure this transparency may be deemed unethical. Even a summary of what information can *potentially* be obtained from the set-up of lifelogging devices by the lifelogger may prove beneficial as it might provide some clarity of what information third parties might

²² This can be especially troublesome if institutions such as governmental or financial institutions can get their hands on lifelog information and circulate wrongful information. The spreading of false information without the necessary checks and balances could severely impair someone's opportunities as has happened. For example, this happened in the Netherlands with a businessperson who was wrongfully arrested several times (ANP 2009). Somehow the databases could not correct the erroneous information. Identity fraud could either be facilitated by lifelogs, as one could steal more information, or impaired as one can hand over more information to correct the situation.

²³ More information on Google Glass can be found at: <http://www.google.com/glass/start/>.

obtain. This again is challenging as this information should be conveyed and presented in a way that is understandable to most or all lifeloggers. Moreover, this information should be accessible without much effort.

- VI. Informed about reliability information:** The lifelogger should be informed about the manipulation of information (retrieval) for purposes such as advertisement. The control over a lifelog is partly determined by the quality of information. The ability to refer to information provides a justification and meaning for one's choices. Information has, for that reason, symbolic value that cannot be underestimated. Hence, it would be unlikely that this lifelog data has no influence on the decisions we make in daily life. The extent to which lifelogs influence beliefs has an effect on the responsibility of developers to explicate the built-in normative standards and to represent information fairly. Therefore, the manipulation of data for the purpose of making a profit could be unethical.²⁴
- VII. Informed about ownership data:** The ownership of data, including activities arising from ownership such as the licensing of lifelog data, should be determined and communicated clearly to the lifelogger to avoid confusion. It should be clear as to what happens when the lifelogger wants to remove the lifelog altogether or passes away, or when the company switches ownership or files for bankruptcy. In addition, limitations on the goals of data use should be formulated and communicated clearly to the lifelogger. Comprehensive but understandable 'terms of use' and/or 'legal terms' - similar to plain language statements for research trials - are paramount but difficult due to the multitude of lifeloggers with different levels of competence and even competent persons can have issues providing consent. Finally, we do not exclude a philosophical discussion on the issues of ownership as the current regulation can be ethically insufficient or unethical. Compliance with legal regulations is insufficient to render lifelogs ethical.
- VIII. Informing others:** The lifelogger should inform others when he/she is recording their information. This can be achieved by the lifelog device indicating it is lifelogging. Instead of being integrated into the fabric of everyday life to the extent that its functioning goes unnoticed, the device which is lifelogging may have to indicate that it is in fact lifelogging to bystanders. This can also be important to the lifelogger [him/her]self as it would leave no doubt whether they are in fact lifelogging.
- IX. Appropriateness of information feedback:** The information obtained from a lifelog can be fed back to the lifeloggers in various forms. It is important to deliver this information appropriately which is largely dependent on the motivation for creating this information and the target audience. Children, for example, are a vulnerable population. If we would not consider legally regulating the use of lifelogs by children for purposes of leisure, we could at least consider adjusting the content and the way it is presented. One could think of the use of metadata with various levels of abstraction using negative descriptions as 'no alcohol consumed', or, 'maintaining a healthy lifestyle', or positive descriptions such as 'at school', or, 'within proximity of the house' instead of raw photos, GPS coordinates or other data. The functionality of lifelogs should be adjustable to the competence of the lifeloggers.
- X. Security:** Data should be stored securely: the security of the data is vital as this is essential for access to and control over our information. This should be considered an integral aspect of the technology. The possibility of third parties, such as governmental institutions or companies, accessing this information should be explained to lifeloggers so they will be aware of the risks of storing their data.

5. Conclusion

²⁴ The quality of information influences the benefits which can be reaped from life providing a *prima facie* reason to allow lifelogs. Hence lifelog should provide information of a sufficient standard of quality. If lifelogs reliably provide information of a sufficient standard, they can be useful for a higher quality of life (Helfert, Walshe, Gurrin 2013).

The history of lifelogs so far shows a clear corporate and governmental interest in lifelogs. Moreover, there seems to be an interest of consumers as well. Although the technology is still at an early stage of development, there has been considerable ethical significance attached to the development of lifelogs.

First, we provided an insight in the current ethical debate on lifelogs by identifying challenges and opportunities. The terminology of challenges and opportunities has been chosen as it distinguishes clearly areas of opportunity and need. By identifying challenges and opportunities in the debate as yet, we hope to inspire others to identify challenges and opportunities that thus far have been barely debated. The identification of challenges and opportunities provides an instrument which could aid the further development of this technology. Our prediction is that some of these newly identified challenges and opportunities will partly arise from blind spots in the current debate regarding users and motivations. Whilst the current debate focuses mainly on lifelogs held by individuals, lifelogs held by governmental institutions and corporations pose idiosyncratic ethical concerns as well. The recent history of lifelogs creates an urgent need to scrutinize the consequences of those entities holding them.

Second, we identified various goals of lifeloggers. By clarifying the concept of lifelogs we provided the conceptual precision necessary to scrutinize the ethical debate we presented. This showed a wide variety of potential domains of applications. The current ethical debate does not distinguish sufficiently between various domains to which lifelogs can be applied. The lack of distinction is problematic as the challenges and opportunities and their weight are dependent on the domain.

Third, we have addressed areas of ethical interest which have yet to be further developed according to our research. Despite the rich academic debate on lifelogs for private individuals, we identified in our discussion some challenges previously left untouched concerning the choice of keeping lifelogs with regard to lifelogs held by private individuals for reasons affecting lifestyle and provided recommendations to alleviate these concerns.

Fourth, we presented a new approach to alleviate ethical concerns regarding the choice of keeping lifelogs which has the benefits of the built-in forgetting as proposed by Dodge and Kitchin (2007) albeit avoiding objections brought forward against them. Moreover, we have advanced ten recommendations which would follow from this framework which can be used as abstract rules of thumb to guide development.

An ethically desirable maturation of the technology requires meeting further challenges and reaping more opportunities. We suggest that further research should identify more specific avenues toward this goal by identifying clearly the uses of lifelogs.

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